

Measuring Distances Beyond the Solar System

The Sun is approximately 150 million (1.5×10^8) km away from Earth.

Proxima Centauri is approximately 40 trillion (4.01×10^{13}) km away from Earth. Most stars are more than 100 trillion (1.0×10^{14}) km from Earth.

Astronomers use **light years** to measure distance to stars or other celestial objects outside the Solar System.

A light year is the distance that light travels in a vacuum (empty space) in one year.

Light in a vacuum travels at 300 000 km/s. This means that 1 light year (ly) is approximately equal to 10 trillion (9.46×10^{12}) km.

SAMPLE PROBLEM 1 Calculating the Distance to a Star in Light Years

If Proxima Centauri is 4.01×10^{13} km from Earth, what is its distance from Earth in light years?

Given: distance to Proxima Centauri = 4.01×10^{13} km
1 ly = 9.46×10^{12} km

Required: distance to Proxima Centauri in light years (ly)

Analysis: distance in light years = 4.01×10^{13} km \times $\frac{1 \text{ ly}}{9.46 \times 10^{12} \text{ km}}$

Solution: distance to Proxima Centauri = 4.24 ly

Statement: The distance from Earth to Proxima Centauri is 4.24 ly.

Practice

Polaris is 400 ly from Earth (Table 1). Calculate the distance from Earth to Polaris in kilometers.

Table 1 Distance of Some Celestial Objects

| Star or galaxy | Approximate distance from Earth (ly) |
|------------------|--------------------------------------|
| Alpha Centauri | 4.3 |
| Vega | 25 |
| Polaris | 400 |
| Deneb | 1400 |
| Andromeda Galaxy | 2 600 000 |

$$400 \times 9.4 \times 10^{12} \text{ km} = 3.8 \times 10^{16} \text{ km}$$

Light travelling from the Sun distance 0.000016 ly away, takes approximately 8 minutes to reach Earth

Light travelling from Vega distance 25 ly takes approximately 25 years to reach Earth.

The Characteristics of Stars

Stars are giant balls of hot gases (usually hydrogen and helium) that produce and emit energy – in the form of heat, light, gamma rays and x-rays. The total amount of energy produced by a star each second is referred to as its **luminosity**.

The Luminosity of a star is measured by comparing it with the luminosity of the Sun, which is assigned a luminosity of 1. Sirius, the brightest star in the night sky found in the constellation of Canis Major, has a luminosity of 22. This means Sirius gives off 22 times more energy each second than the Sun.

The Sun will always appear brighter because it is closer to us.

How to describe Stars

The colour of a star gives an indication of the star's surface temperature.

Relatively Speaking

Table 2 Colour and Temperature Ranges of Some Stars

| Colour | Temperature range (°C) | Example(s) |
|-----------------|------------------------|---------------------|
| bluish | 25 000–50 000 | Zeta Orionis |
| bluish-white | 11 000–25 000 | Rigel, Spica |
| whitish | 7500–11 000 | Vega, Sirius |
| yellowish-white | 6000–7500 | Polaris, Procyon |
| yellowish | 5000–6000 | Sun, Alpha Centauri |
| orangish | 3500–5000 | Arcturus, Aldebaran |
| reddish | 2000–3500 | Betelgeuse, Antares |

Answer the following questions:

1. What do astronomers mean when they refer to a star's luminosity?
2. Why was the star Sirius significant to some ancient cultures?
3. . Figure 5 shows four coloured spheres, representing the colours of four stars. In your notebook, list which colour you think corresponds with the following temperatures: 3100 °C, 4800 °C, 8000 °C, 10 200 °C. [T/1](#)



Figure 5

The distance of stars and galaxies can be measured in light years